A Proposal for a

MINOR IN PLANETARY SCIENCES

College of Natural and Agricultural Sciences
University of California – Riverside
Riverside, CA 92521
Proposal for Minor in Planetary Sciences

Minor in Planetary Sciences Approvals

<table>
<thead>
<tr>
<th>Approvals</th>
<th>Dates</th>
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<tbody>
<tr>
<td>Approved by the faculty of the Department of Earth and Planetary Sciences</td>
<td>10/20/2021</td>
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<tr>
<td>Approved by the Executive Committee of the College of Natural and Agricultural Sciences</td>
<td>02/07/2023</td>
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<tr>
<td>Approved by the Committee on Educational Policy</td>
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Contact Information

For any questions, please contact:

Stephen Kane, PhD
Email: skane@ucr.edu
Department of Earth and Planetary Sciences
University of California Riverside, CA 92521 USA

Edward Schwieterman, PhD
Email: eschwiet@ucr.edu
Department of Earth and Planetary Sciences
University of California Riverside, CA 92521 USA
Proposal for Minor in Planetary Sciences

1. Name of the academic program and the department(s) or unit(s) that will administer the program

   Name: Minor in Planetary Sciences
   Department: Earth and Planetary Sciences

2. A thorough justification, including the motivation for the creation of the program in terms of student interest and professional or academic importance.

   This section outlines a proposal for a minor in Earth and Planetary Sciences (EPS), which will be solely managed by faculty within the Department of Earth and Planetary Sciences.

   **Motivation and Program Objectives**

   The Department of Earth and Planetary Sciences has implemented numerous changes in recent years to better reflect the broadened scope of research occurring within the department, including the name change for both the department, and for the graduate program. We are continuing this process by adjusting our undergraduate programs to better reflect our broader inclusion of planetary sciences in research and instruction. As part of these changes to the undergraduate program, we are adding a Minor in Planetary Sciences.

   This minor is envisioned as option for Physics and Astronomy majors or other CNAS students who are interested in pursuing future graduate studies in planetary sciences, exoplanet astronomy, and/or astrobiology by supplementing the courses in their major program. Additionally, the program may be of interest to BCOE students who are interested in applying engineering principles to planetary science exploration. A student who completes the minor track will have obtained core competencies in planetary sciences that will enhance their appeal to relevant graduate programs and potential career opportunities in the public and private sectors (e.g., NASA and private space companies).

3. Relationship of the new program to existing programs.

   The Planetary Sciences minor is complementary to our other departmental minor programs that reflected the changes to the research goals of the department. The Planetary Sciences minor is appropriate for those students who wish to gain a competency in planetary sciences without the larger course obligations of the Planetary Sciences Concentration within the Earth and Planetary Sciences major.

4. The proposed curriculum. Great care should be given in this area, correct rubrics should be listed for courses, all cross listings should be listed, unit total considerations should be taken into account and totals should be verified by program staff, faculty, and appropriate Executive Committee personnel. A copy of the proposed program change should be provided for inclusion in the Catalog.
Curricular Structure and Requirements

The minor requires three lower-division and four upper-division courses. The lower-division courses are GEO 013 (Our Planetary Neighbors: The Solar System and Beyond), GEO 080 (Astrobiology: The Search for Life in the Universe), and one of several lower division geoscience courses that covers geology, oceanography, or climate. The general lower division geoscience requirement is meant to give students a broad understanding of the Earth system specifically, which will be put into a broader planetary context via the remaining required courses. The minor requires our newest planetary science courses as upper-division requirements, including GEO 180 (Exoplanet Science Detection Techniques), GEO 181 (Exoplanetary Science Characterization), GEO 182 (Planetary Astrobiology), and GEO 184 (Planetary Atmospheres).

The following are the requirements of the Planetary Sciences Minor.

1. Lower-division requirements (12 units):
   GEO 001 or GEO 002 or GEO 006 or GEO 009 or GEO 011; GEO 013 and GEO 080

2. Upper-division requirements (20 units):
   GEO 180, GEO 181, GEO 182, GEO 184, 4-5 units in any upper-division Geosciences course

There are no cross listings or new courses. A copy of the proposed program change is provided for inclusion in the Catalog in Appendix A.

5. A list of faculty who will be involved in the program, including those teaching, advising, and administering.

Supporting Faculty for the Minor in Planetary Sciences

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Department</th>
<th>Position</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryjo Brounce</td>
<td>Earth and Planetary Sciences</td>
<td>Associate Professor</td>
<td>Petrology, planetary surfaces and interiors</td>
</tr>
<tr>
<td>Stephen Kane</td>
<td>Earth and Planetary Sciences</td>
<td>Professor</td>
<td>Exoplanet detection, exoplanet characterization, planetary habitability</td>
</tr>
<tr>
<td>Sandra Kirtland-Turner</td>
<td>Earth and Planetary Sciences</td>
<td>Associate Professor</td>
<td>Climate science, oceanography</td>
</tr>
<tr>
<td>Wei Liu</td>
<td>Earth and Planetary Sciences</td>
<td>Assistant Professor</td>
<td>Climate science, oceanography</td>
</tr>
<tr>
<td>Gordon Love</td>
<td>Earth and Planetary Sciences</td>
<td>Professor (EPS Chair)</td>
<td>Molecular organic geochemistry, biogeochemistry</td>
</tr>
</tbody>
</table>
Course Instructors for Minor in Planetary Sciences

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>GEO 001*</td>
<td>The Earth’s Crust and Interior</td>
<td>Maryjo Brounce and various</td>
</tr>
<tr>
<td>GEO 002*</td>
<td>Earth’s Climate Through Time</td>
<td>Timothy Lyons</td>
</tr>
<tr>
<td>GEO 006*</td>
<td>Planets in Science Fiction</td>
<td>Stephen Kane</td>
</tr>
<tr>
<td>GEO 009*</td>
<td>Oceanography</td>
<td>Sandra Kirtland Turner, Maryjo Brounce, and various</td>
</tr>
<tr>
<td>GEO 011*</td>
<td>Global Climate Change</td>
<td>Wei Liu and various</td>
</tr>
<tr>
<td>GEO 013</td>
<td>The Solar System and Beyond</td>
<td>Edward Schwieterman</td>
</tr>
<tr>
<td>GEO 080</td>
<td>Astrobiology: The Search for Life</td>
<td>Stephane Kane and Timothy Lyons</td>
</tr>
<tr>
<td>GEO 180</td>
<td>Exoplanet Science Detection Tech.</td>
<td>Stephen Kane</td>
</tr>
<tr>
<td>GEO 181</td>
<td>Exoplanet Science Characterization</td>
<td>Stephen Kane</td>
</tr>
<tr>
<td>GEO 182</td>
<td>Planetary Astrobiology</td>
<td>Edward Schwieterman</td>
</tr>
<tr>
<td>GEO 184</td>
<td>Planetary Atmospheres</td>
<td>Edward Schwieterman</td>
</tr>
</tbody>
</table>

*Only one of these listed courses required for minor.

Course Descriptions

**GEO 001* The Earth’s Crust and Interior** (4 credits) Lecture, 3 hours; laboratory, 3 hours; one 1-day field trip. Prerequisite(s): none. An introduction to the physical development of the Earth. Emphasis will be on Earth materials (rocks and minerals), processes (weathering, erosion, mountain building), structures (folds and faults), and current theories regarding the Earth’s crust and interior.

**GEO 002* Earth’s Climate Through Time** (4 credits) Lecture, 3 hours; laboratory, 3 hours; one 2-day field trip. Prerequisite(s): none. An introduction to the history of Earth’s changing climate and its relationship to the evolution of life on human to geologic time scales. Topics include the interrelationships among short- and long-term carbon cycling; plate tectonics; ocean and atmosphere circulation; and greenhouse gases through time.

**GEO 006* Planets in Science Fiction** (4 credits) Lecture, 3 hours; discussion, 1 hour; extra reading, 3 hours. Prerequisite(s): none. Introduces the history of discoveries in planetary science and exoplanets and the influence on popular culture, movies, television, literature, and video games. Topics include planet discovery and exploration, planetary habitability, desert worlds, water worlds, moons, and terraforming in the context of science fiction.

**GEO 009* Oceanography** (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. A general introduction to the geological, physical, chemical, and biological processes related to
the characteristics and evolution of the ocean system. Explores the role oceans play in regulating climate and the cycling of elements on the Earth’s surface. Illustrates how the ocean system has been, and continues to be, one of the most important influences on life.

**GEO 011 Global Climate Change** (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. Provides an understanding of Earth’s feedback systems that regulate the climate over long and short-term time scales. Includes oceanic and atmospheric circulation patterns, the major reservoirs and global carbon cycle, and the influence and origin of greenhouse gases. Investigates sustainability, climate change policies, adaptation, and mitigation. Credit is awarded for only one of GEO 011 or GEO 011H.

**GEO 013 Our Planetary Neighbors: The Solar System and Beyond** (4 credits) Lecture, 3 hours; discussion, 1 hour; extra reading, 3 hours. Prerequisite(s): none. A survey of the planets in the solar system with a focus on comparative planetology. Explores the formation, structure, composition, and evolution of rocky and gas giant planets. Other topics include the night sky, the Moon, gravity, planetary motion, radiation, minor bodies, and exoplanets.

**GEO 080 Astrobiology: the Search For Life in the Universe** (4 credits) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): none. Are we alone in the universe? This basic human question, once solely the domain of philosophy and science fiction, is now a field of considerable scientific research. Lecture and lab topics include the history of life on Earth, habitability in the solar system, and discovery of planets around other stars.

**GEO 180 Exoplanetary Science Detection Tech** (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 007B or MATH 009B or MATH 09HB; PHYS 040B or PHYS 002B; PHYS 117 or GEO 111; Restricted to class level standing of junior, or senior; or consent of instructor. Covers the rapid expansion of the subject of exoplanets, the discoveries of which now number in the thousands and include planets smaller than Earth. Topics include solar system formation, the history of exoplanetary science, orbital mechanics, detection methods, orbital ephemerides, host stars, and future exoplanet space missions.

**GEO 181 Exoplanetary Science Characterization** (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 007B or MATH 009B or MATH 09HB; PHYS 040B or PHYS 002B; PHYS 117 or GEO 111; GEO 180; Restricted to class level standing of junior, or senior; or consent of instructor. Covers the detailed characterization of exoplanets including new discoveries that are being made from past and present exoplanet missions. Topics include orbital dynamics and architectures, tidal effects, planet formation, circumbinary planets, phase variations, planetary atmospheres, exomoons, and future exoplanet space missions.

**GEO 182 Planetary Astrobiology For Science Majors** (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 001B or CHEM 01HB; MATH 007B or MATH 009B or MATH 09HB; PHYS 002B or PHYS 02HB or PHYS 040B or PHYS 040HB; or consent of instructor. An overview of the origin, evolution, distribution, and future of life in the universe. Explores the physics and chemistry of life; formation and evolution of planets; origin of life; habitable environments in the solar system (Mars, Venus, icy moons); exoplanet biosignatures; and the search for extraterrestrial intelligence.
GEO 184 Planetary Atmospheres (4 credits) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 007B or MATH 009B or MATH 09HB; PHYS 002B or PHYS 02HB or PHYS 040B or PHYS 040HB; restricted to class level standing of junior, or senior; or consent of instructor. A quantitative overview of the atmospheric structure, composition, climate, evolution, and circulation of planets within and outside the solar system. Focus areas include hydrostatic equilibrium, convection and lapse rates, photochemistry, escape processes, radiative transfer and spectroscopy, atmospheric formation, and basic fluid mechanics applied to circulation. Credit is awarded for one of the following GEO 184 or GEO 284.

6. For interdisciplinary programs, the degree of participation and the role of each department must be explicitly described. The chairs of all participating departments must provide written approval for the creation of the program and indicate their commitment to provide necessary resources including faculty release.

This program is not interdisciplinary (does not cross departments).

7. Projected enrollment in the program.

Since the program is a minor, we expect that the total enrollment will include many students outside of the EPS department. We anticipate enrollment to evolve as follows.

<table>
<thead>
<tr>
<th>Year</th>
<th>Projected Enrollment</th>
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<tbody>
<tr>
<td>2023-2024</td>
<td>5</td>
</tr>
<tr>
<td>2024-2025</td>
<td>8</td>
</tr>
<tr>
<td>2025-2026</td>
<td>10</td>
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<tr>
<td>2026-2027</td>
<td>15</td>
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<tr>
<td>2027-2028</td>
<td>25</td>
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8. Name of degree, if applicable, and the anticipated number of degrees to be granted when the program reaches steady state.

The name of the degree is Minor in Planetary Sciences. The anticipated number of degrees (per year) will be ~10-15, assuming those enrolled are primarily juniors and seniors (i.e., half of the enrolled students graduating per year).

9. Potential impact of the new program on existing programs. If the proposed program includes required courses from a department other than the administering department, the proposal must include a statement from the department indicating that it has been consulted and that it will provide access to the required courses.

We do not anticipate any impact on other programs, since there are no similar programs offered elsewhere in CNAS. All the courses are already taught either as service courses or to fulfill the requirements of an EPS major or major concentration.

10. A full listing of resources required for start-up and for operations. In cases where no additional resources will be needed, this must be explicitly stated. This listing may include: personnel (faculty FTE or temporary positions, Teaching Assistants or
Proposal for Minor in Planetary Sciences

Readers, administrative staff, technical support); support services including computer facilities and library resources; space requirements. A plan indicating how the resources will be obtained would also be helpful to the committee in reviewing the proposal. A letter of support from the College Dean and/or Executive Vice Chancellor-Provost indicating endorsement as well as a promise of support for the proposal also would be extremely helpful.

No additional resources are required.

11. Both internal and external letters of support should be provided with the proposal. Internal letters of support are often from UCR department chairs and faculty of related programs. The external letters should be from other UC campuses or other peer institutions. Letters from off-campus help to establish the quality of the program and its fit within the context of related programs at other universities. Upon consultation with the CEP the demand for external letters may be waived.

Letters of support are attached (see Appendix B) from the following:

- Earth and Planetary Sciences Department Chair

12. Approvals from program faculty, College faculty (if the new proposal affects a college regulation), and the appropriate Executive Committee should be obtained before forwarding the new program to the attention of the Senate Analyst for CEP.

The EPS faculty have approved the new program, and it is now ready for the CNAS Executive Committee approval.

13. All proposals for new programs should be submitted to the Senate Chair no later than March 1 of the academic year prior to the fall quarter in which the proposed program is anticipated to go into effect. This schedule should provide sufficient time for Senate review of the proposal to meet the deadline for final consideration of approval at the May Division Meeting.

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Students who wish to Minor in Geology, Geophysics or Global Climate Change must complete 20-28 units of organized upper-division courses in Geosciences. A minimum of 16 of these units must be unique to the minor and cannot be used to satisfy major requirements. To satisfy prerequisites, additional preparatory coursework in Earth and Planetary Sciences and other sciences (Biology, Chemistry, Mathematics, Physics) may be required.

Minor in Geology: GEO 001, GEO 115; plus 15-23 additional upper-division Geosciences units.

Minor in Geophysics: GEO 001; GEO 140; plus 16-24 additional units taken from GEO 115, GEO 116, GEO 132, GEO 144, GEO 145, and GEO 190.

Minor in Global Climate Change: GEO 001 or GEO 002; GEO 011; GEO 160; plus 16-24 additional upper-division Geosciences units.

Minor in Planetary Sciences: GEO 001 or GEO 002 or GEO 006 or GEO 009 or GEO 011; GEO 013 and GEO 080; GEO 180, GEO 181, GEO 182, and GEO 184; plus 4-5 units in any upper-division Geosciences course.

Before submitting a petition for a Minor to the college, students interested in pursuing a Minor in Geology or Geophysics or Global Climate Change must consult with the undergraduate faculty advisor in Earth and Planetary Sciences.
Proposal for Minor in Planetary Sciences

Justification: The Department of Earth and Planetary Sciences has implemented numerous changes in recent years to better reflect the broadened scope of research occurring within the department, including the name change for both the department, and for the graduate program. We are continuing this process by adjusting our undergraduate programs to better reflect our broader inclusion of planetary sciences in research and instruction. As part of these changes to the undergraduate program, we are adding a Minor in Planetary Sciences. This minor is envisioned as option for Physics majors or other CNAS students who are interested in pursuing future graduate studies in planetary sciences, exoplanet astronomy, and/or astrobiology by supplementing the courses in their major program. The minor requires three lower-division and four upper-division courses. The lower-division courses are GEO 013 (Our Planetary Neighbors: The Solar System and Beyond), GEO 080 (Astrobiology: The Search for Life in the Universe), one of several lower division geoscience courses that covers geology, oceanography, or climate. The minor also requires our newest planetary science courses as upper-division requirements, including GEO 180 (Exoplanet Science Detection Techniques), GEO 181 (Exoplanetary Science Characterization), GEO 182 (Planetary Astrobiology), and GEO 184 (Planetary Atmospheres). A student who completes the minor track will have obtained core competencies in planetary sciences that will enhance their appeal to relevant graduate programs and potential career opportunities in the private and public sectors (e.g., NASA).

Approvals:

Approved by the faculty of the Department of Earth and Planetary Sciences: 10/20/2021
Approved by the Executive Committee of the College of Natural and Agricultural Sciences:
Approved by the Committee on Educational Policy:
APENDIX B: LETTER OF SUPPORT

- Earth and Planetary Sciences Department Chair
To Whom It May Concern,

I am writing to strongly endorse the creation of a Planetary Sciences Minor within the Department of Earth and Planetary Sciences. The creation of this minor is reflective of the expanded focus of our department to include the planetary sciences alongside the Earth sciences. The proposed minor program specifically complements the creation of a Planetary Science Concentration within the Earth and Planetary Sciences major (renamed from Earth Sciences), which has already been approved by the Academic Senate. The minor is appropriate for CNAS students from other departments and majors who wish to gain competency in planetary sciences. Please see the proposal for a full justification for the creation of the minor.

The Department of Earth and Planetary Sciences can fully support the proposed minor program with no additional resources. Each course in the Minor in Planetary Sciences is already taught to fulfill other objectives of the department including requirements for existing majors and major concentrations. The minor proposal was unanimously endorsed by the department’s faculty on October 20, 2021. We are looking forward to the approval of this new program.

Sincerely,

Gordon Love
Chair and Professor
Department of Earth and Planetary Sciences
E-mail: glove@ucr.edu